

Validation of VIIRS nighttime lights using SQM measurements at Belgrade and Vidojevica

A PRELIMINARY STUDY

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Introduction

Light pollution is one of the fastest-growing environmental pollutants, affecting ecosystems, sleep and traffic safety. Satellites such as VIIRS record light emitted upward, while ground-based Sky Quality Meters (SQM) measure the night-sky brightness people actually experience. Linking the two is essential for local monitoring, yet the Balkans remain largely under-researched.

Study Sites

- Kalemegdan (ADRB)** Belgrade city centre, highly urbanized. 44.825°N, 20.451°E. Apr 2024 – Dec 2025.
- Observatory (AOB)** Zvezdara, Belgrade; urban green area. 44.802°N, 20.513°E. Jun 2025 – Jun 2026.
- Vidojevica (ASV)** Rural mountain site, Prokuplje 1150 m.a.s.l. 43.141°N, 21.556°E. Mar 2025 – Jun 2026.

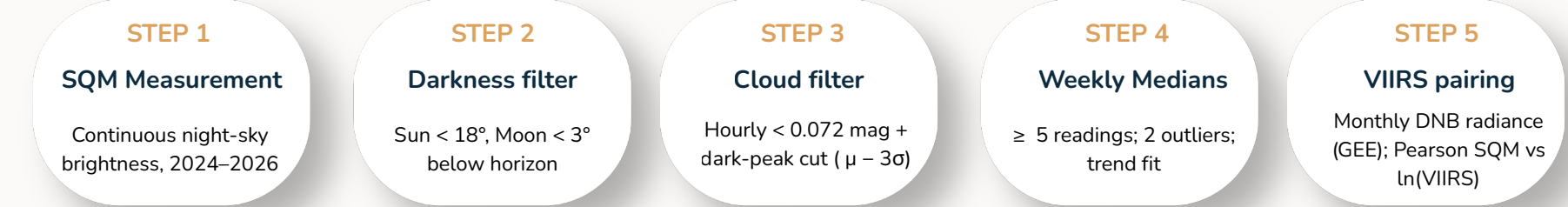
Results & Discussion

Study Site	Readings	SQM · NIGHT-SKY BRIGHTNESS			VIIRS · RADIANCE	
		Valid (clear, dark)	Wkl. Medians	Clear-sky Peak	Trend (mag/yr)	Mean ± SD
Kalemegdan	541,687	13,390 (2.5%)	32	16.06 ± 0.26	-0.022 ± 0.018	89.3 ± 19.0
Observatory	89,581	4,669 (5.2%)	40	18.26 ± 0.20	-0.035 ± 0.117	27.2 ± 3.9
Vidojevica	96,845	7,136 (7.4%)	52	20.98 ± 0.31	+0.082 ± 0.086	0.45 ± 0.11

SQM peak in mag/arcsec²; trends are indicative only (series of ~1–1.7 years), negative = brightening, none statistically significant. ASV trend **covers the full record** (Mar 2025 – Jun 2026). VIIRS in nW/cm²/sr, over the months paired with SQM (n = 11, 11, 13).

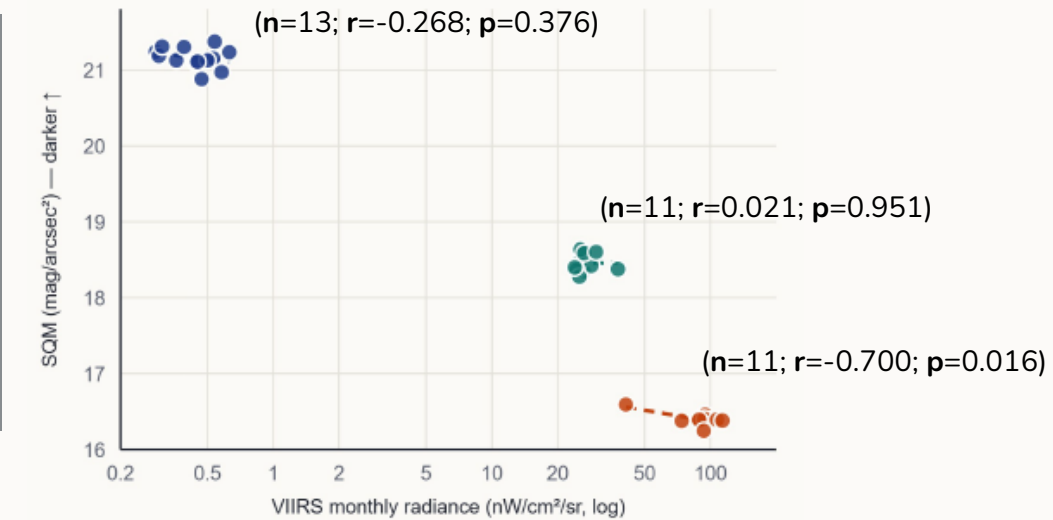
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Data & Methods

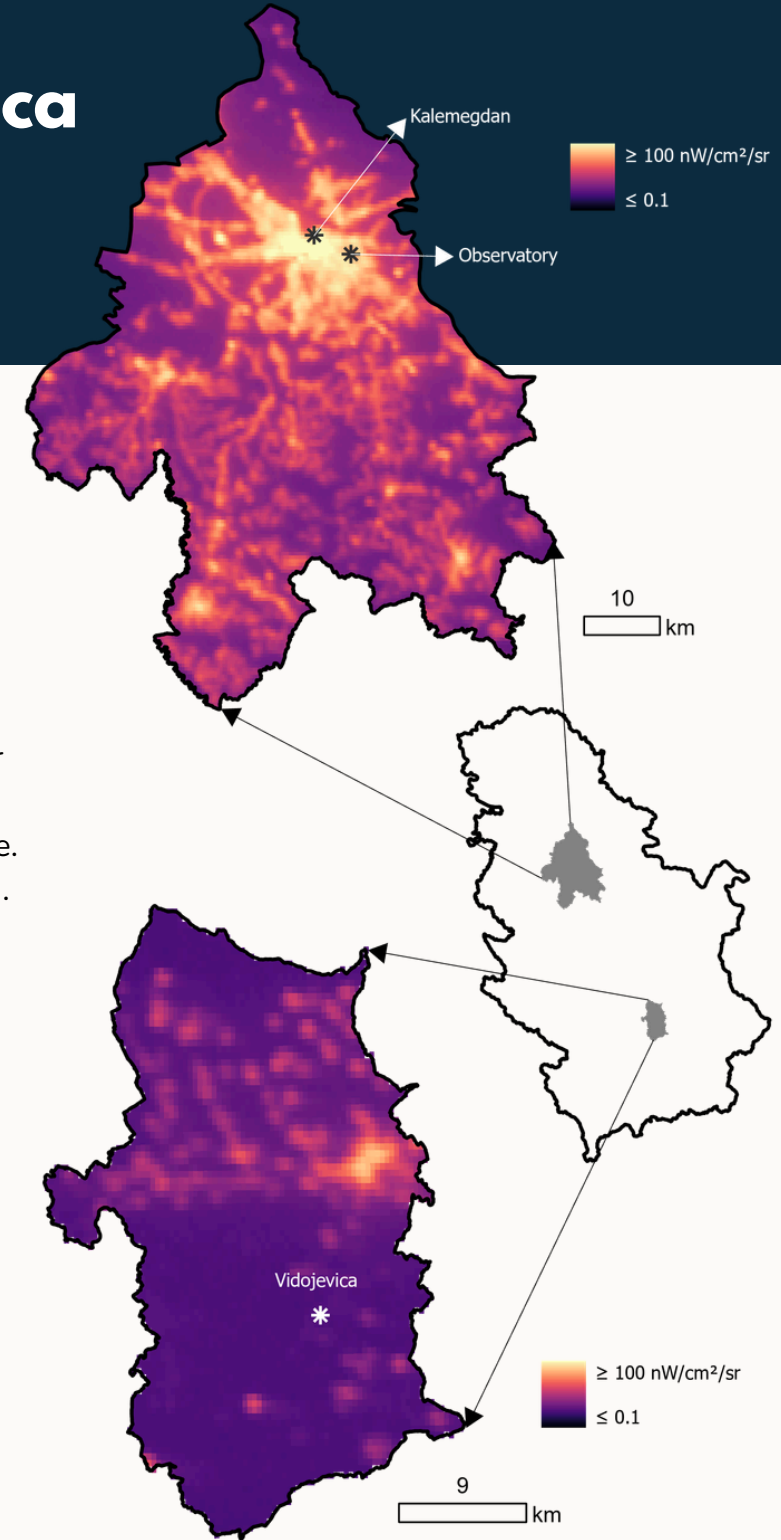


Aggregation and statistics. Clear-sky readings were summarised as weekly medians (≥ 5 readings); medians beyond 2σ of a linear trend were flagged as outliers for the trend analysis but retained in the correlation. Monthly NSB was calculated as the mean of weekly medians and paired with VIIRS DNB monthly average radiance (nW/cm²/sr) extracted at each station in Google Earth Engine. Agreement was tested with Pearson's r between monthly NSB and log-transformed VIIRS radiance (n = 11–13 months per station).

SQM data. Unihedron SQM-LU photometers recorded night-sky brightness (NSB, mag/arcsec²; higher values = darker sky). Following Shah et al. (2025), only readings from astronomical night (Sun > 18° below the horizon) with the Moon > 3° below the horizon were kept, and cloudy hours were removed with a statistical filter (hourly NSB standard deviation < 0.072 mag). As an addition to that method, a cut below the clear-sky histogram peak (μ – 3σ) removed uniformly overcast nights. This retained 2.5–7.4% of all readings, consistent with other SQM networks.



- Kalemegdan (ADRB)** significant logarithmic correlation; the satellite–ground relationship is clearest under strong artificial illumination.
- Observatory (AOB)** negligible correlation, probably because monthly NSB varied only between 18.27 and 18.64 mag/arcsec².
- Vidojevica (ASV)** weak, non-significant correlation, owing to the very low VIIRS values (0.29–0.63 nW/cm²/sr) typical of rural areas.



Conclusion

- SQM–VIIRS validation is viable in Serbia; agreement is strongest where artificial light is highest.
- Vidojevica is documented as a dark-sky site (clear-sky NSB 20.98 mag/arcsec²), suitable for astronomical observations.
- Next steps: extend the SQM network across Belgrade's urban quarters and observe for at least 3–5 years.